



Effects of Lower Leg Therapeutic Taping on Balance in Central Nervous System Diseases: A Systematic Review of Literature

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Abstract

Context: Balance control results from multiple interactions between different systems: input from the visual, the somatosensory, and the vestibular systems are integrated and regulated by the central nervous system to ensure standing balance. One of the effective interventions is using ankle taping. The purpose of this review was to assess the effectiveness of ankle taping on balance in central nervous system diseases.

Evidence Acquisition: This study is a systematic review and databases PubMed, Cochrane Library, Google Scholar, Science Direct, Ovid, Scopus, and Web of Science were searched for original scientific articles that were published between January 1990 to July 2018. Studies investigating the effect of therapeutic ankle taping on balance in central nervous system diseases were included. The PEDro quality scale was used to investigate the studies included; it investigates taping, balance, central nervous system disease.

Results: Seven articles were included from 256 relevant articles. There were differences among the studies in terms of methodology, design, outcomes, sample size, procedure, etc. The results showed that using lower leg taping can be effective in balance improvement.

Conclusions: Using lower leg taping can be effective in balance improvement in central nervous system diseases.

Keywords: Central Nervous System Diseases, Therapeutic Taping, Balance

1. Context

Patients with central nervous system (CNS) damage experience reduced balance control, which greatly impacts their ability to perform daily activities (ADLs) (1-4). Weak balance may be due to cognitive alteration, reduced muscle power, decrease in range of motion, impairment in muscle tone, uncoordinated movements, or sensory changes (1). Balance is controlled by the complex interaction of sensory and motor system. Accurate perception of visual, motor-sensory, and vestibular system stimulations, and correct setting of these stimulations are essential for good balance (5, 6).

Taping technique is one of the most popular clinical interventions that are widely used to help balance improvement and walking practice. It helps to absorb lymph, blood circulation, and even joint fixation. A recent study has reported that the use of specific tension in taping can decrease the pain as it improves the range of motion, proprioception, muscle tone, and balance parameters (7-9). It

has reported that elastic taping is also a valid technique for reducing spasticity and related symptoms in a short period of time and improving balance and walking in people with spinal cord injury (9). In addition, non-elastic taping is a useful method for correcting joint alignment and enhancing muscle activity for the generation of force after musculoskeletal injuries (10, 11). The exact mechanism of how ankle taping may increase stability is not fully understood. Both mechanical and proprioception effects have been raised. The mechanical effects of the tape are well documented. Several studies have shown a decrease in the rate of inversion and ankle plantarflexion following the use of the taping (12). In recent years, increased cutaneous stimulation through neuromuscular Kinesio tape has been proposed to increase motor-sensory inputs (13). Kinesio tape can increase or inhibit muscle activity (14) and can also increase the range of motion (ROM) and ankle stability (15). Studies showed that Mulligan taping is also an effective intervention for functional improvement and joint align-

ment, and it also helps postural regulation. Ankle taping (Mulligan) significantly increases the dynamic stability and gait of stroke subjects (16). Therefore, the purpose of this study is a systematic review of studies that have evaluated the effect of ankle taping on balance in patients with central nervous system (CNS) damage.

2. Evidence Acquisition

This study is a systematic review and scientific databases such as Cochrane Library, Ovid, PubMed, Google Scholar, Science Direct, Scopus, and Web of Science were searched for published original papers between January 1990 to July 2018. Figure 1 presented the fellow chart of the study. In this search, we used the English keyword: taping, balance, and central nervous system disease. First, two browsers examined all the titles in the databases, and related topics were reviewed for an article summary. Article summaries related to research study were isolated, and then the similar articles were deleted. If any of the browsers were unable to determine the inclusion and exclusion of study based on the title and abstract, the entire article would be checked. The full text of the remaining articles was evaluated based on inclusion and exclusion criteria. The first and second browser scanned all retrieved articles independently, and the third browser, which has more experience in this field checked some articles randomly. If the first and second browsers did not agree on the inclusion and exclusion of an article, in this case, they consulted with the third browser until they reached the final deal. The inclusion criteria of this study were studies carried out on human specimens, studies published in English, clinical trials studies, studies that examined the effect of taping on balance in patients with tapes of central nervous system damage, and also studies where taping intervention had been performed on the ankle, leg, and knee region. The exclusion criteria were studies that examined the effect of taping on other neurological problems except for central nervous system involvement, studies that used taping in regions other than the ankle, leg, and knee, studies that examined the effect of taping on the other parameters except patient balance and studies published in the other languages except English. In order to evaluate the quality of the articles, considering that all identified studies were a clinical trial, the PEDro scale was used, and the evaluation result is presented in Table 1. It should be noted that articles were included in the study which, in terms of quality of assessment, they score more than six points. Due to the fact that identified articles

did not have the same situation in terms of study type, method of implantation, and measurement parameters, it was not possible to carry out a meta-analysis study on included studies.

3. Results

Among the 256 studies, and by using the keywords mentioned, seven articles had an inclusion criteria and were evaluated (Figure 1). The summary of the findings of these articles is presented in Table 2. All of the articles in this study were a clinical trial that examined the short-term effect of taping on the balance in patients with central nervous system damage, however, in terms of the indicators examined, type of taping, regions of intervention, duration of intervention, and the manner of the studies conducted were different.

3.1. Outcomes Measure

In most of the included studies, balance ability was been used as an indicator of the effect of taping on balance (9, 16-18). In addition, among the identified studies, in two studies (18, 19) central of pressure displacement test, in two studies (8, 18) test of stability range, and in three studies (9, 16, 19) gait test and parameters and the ability of gait were used to assess the effect of taping on balance. In three studies, the Berg Balance Scale was used to measure the indicator of balance ability (9, 18, 19). Timed up and go test was also used in two studies to measure the indicators of gait ability (9, 19). The Biorescue device was used in two studies to measure the level of stability (8, 18). To assess the center of pressure area, using a camera system (18), force plate (19), and Biorescue (8) has been reported. In addition, in a study, "Shisei" innovation system was used to measure and analyze the kinematics of motion, posture, and foot pressure (7).

3.2. Intervention

Among the identified studies, in six studies the effect of taping on the balance of subacute (16-18) and chronic (7, 8, 19) stroke patients and in one study the effect of taping on the balance in subjects with chronic spinal cord injury (9) was examined. In addition, among the included studies, in six studies the effect of Kinseio tape (7, 9, 17-19) and in one study the effect of Mulligan tape (16) on balance was examined. The results and interventions are detailed in Table 2.

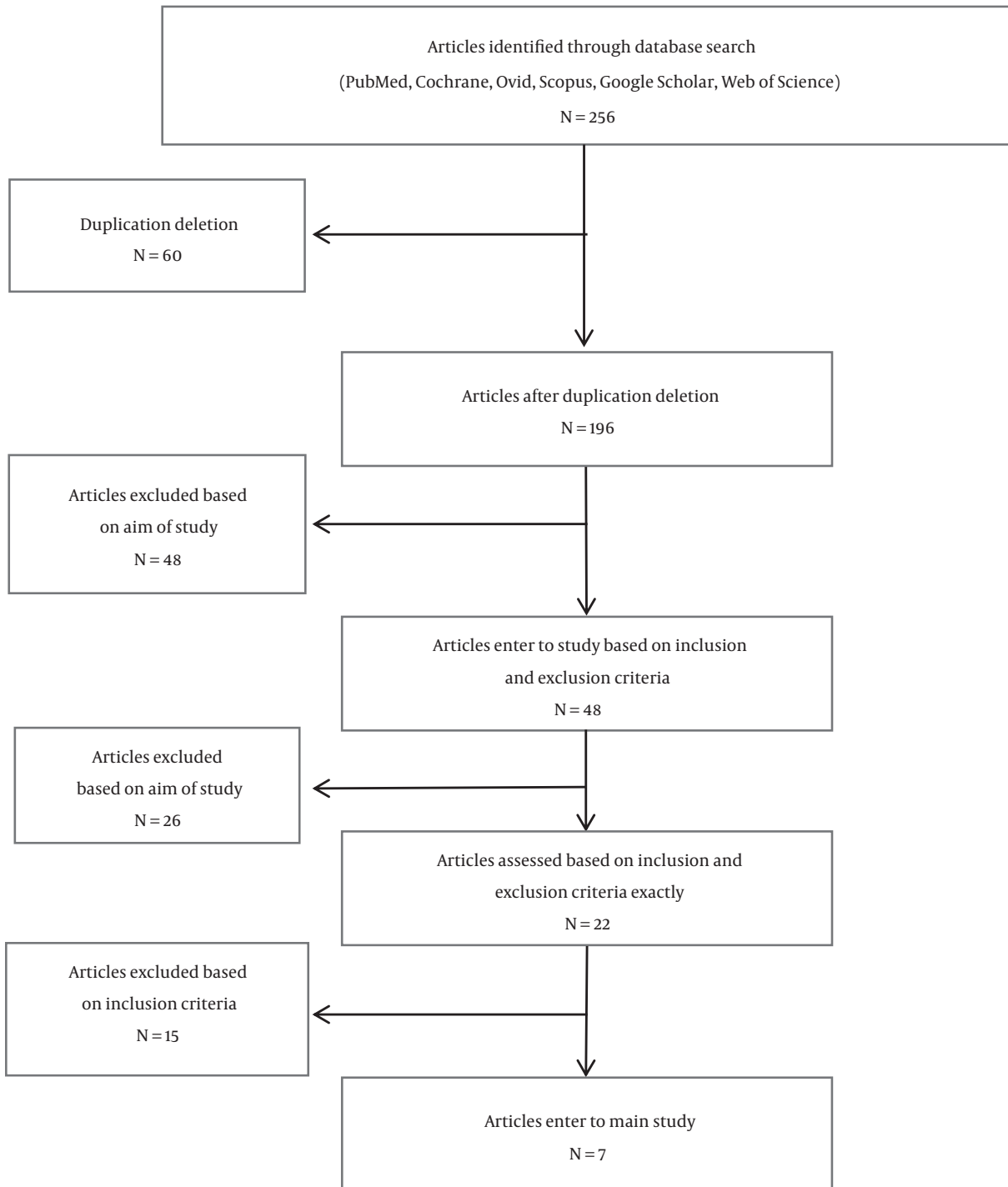


Figure 1. How to enter the articles into the systematic review

Table 1. Judgment of Papers According to the PEDro Scale

PEDro Scale	Bae, 2015 (17)	Hyun, 2015 (16)	Rojhani- Shirazi, 2015 (18)	Shin, 2017 (8)	Tamburella, 2014 (9)	Yang, 2015 (7)	Yazici, 2015 (19)
Eligibility criteria were specified	+	+	+	+	+	+	+
Subjects were randomly allocated to groups	+	+	+	+	+	+	+
Allocation was concealed	-	-	-	-	-	-	-
The groups were similar at baseline	+	+	+	-	+	-	-
There was blinding of all subjects	-	-	-	+	-	-	+
There was blinding of all therapists who administered the therapy	-	-	-	+	-	-	-
There was blinding of all assessors	-	-	+	+	+	-	-
Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups	+	+	+	+	+	+	+
All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyzed	+	+	+	+	+	+	+
The results of between-group statistical comparisons are reported for at least one key outcome	+	+	+	+	+	+	+
The study provides both point measures and measures of variability for at least one key outcome	+	+	+	+	+	+	+
Total score	7	7	8	9	8	6	7

4. Discussion

The findings from this systematic review provide evidence for the beneficial effect of taping methods on balance control in individuals with central nervous system damage; however, more documentation is required. The improvement in balance may result from the additional support of kinesiotope on the ankle joint, which can facilitate movement control and joint stabilization (18, 20). It has been reported to restrict severe joint movement and improve proprioception feedback; as a result, the reaction time of joint stabilizer muscles decrease, therefore, Kinesiology taping has immediate positive effects on static balance in stroke patients (18). Tamburella et al. observed a decrease in time of stance phase and also decrease in double

stance phase following the use of kinesiology tape on the ankle in subjects with incomplete spinal cord injury. It reflected the improvement of dynamic postural stability suggested to improve balance and gait, especially in these subjects (9). To determine the possible mechanism of these improvements, CI (as an index of spasticity in stroke subjects) showed a significant reduction in EMG activity of agonist vs. antagonist ankle muscles immediately after using kinesiology tape suggesting improved motor outcomes. Therefore, kinesiology tape is a valid method to decrease spasticity and related signs in a short time and make better stability and gait in chronic incomplete spinal cord injuries participants (9). Additionally, neuromuscular taping improved gait, balance, pain, and ability to walk and conduct daily activities in multiple sclerosis patients (21, 22). The

Table 2. Characteristics of Included Papers

Study/Author	Year	Subjects Characteristics	Diseases Type	Device/System for Measurement	Areas of Interventions	Outcome Measure	Result*
Bae (7)	2015	n = 30; exp: 15; cont: 15	Stroke (Subacute stage)	Gaitview system Biorescue	- fibularis longus - fibularis tertius - extensor digitorum - anterior tibialis Taping for extra support around ankle joint	-BBS, -COPA, -LOS	Within a group, both groups had a sig. improvement on BBS & COPA & LOS ($P < 0.05$). Between group, No sig. differences ($P > 0.05$) BBS; but sig. differences ($P < 0.05$) in COPA & LOS. The kinesiology tape has temporary positive effects on balance improvement in stroke patients.
Hyun (6)	2015	n = 30; exp: 15; cont: 15	Stroke (Subacute stage)	-biodex, -gaitrite system	Knee joint	-balance ability, -gaittest, -cadence, -gait velocity, -step length, -stride length	-Gait parameters in experimental group $P < 0.05$, -standing dynamic balance or gait in control group $P > 0.05$. -Standing dynamic balance, cadence and gait speed comparison between two groups $P < 0.05$. Mulligan tape is effective in balance improvement and gait in stroke (subacute) subjects, so this method is a great treatment for active facilitation rehabilitation
Rojhanishirazi (8)	2015	n = 40; exp: 20; cont: 20	Stroke (Chronic: > 6 months)	-Force plate	Ankle taping for correct equinovarus/valgus deformity	-BBS, -TUG, -COP displacement, -gait ability, -velocity	-In the first day, no significant difference between groups in variables of postural control. 24 hours after using tape, there was a significant difference between groups in functional reach test ($P = 0.04$) and COP medial/lateral displacement and no significant difference between groups showed. 24 hours after taping, the BBS score was significantly higher than the first day in kinesiology tape group. -BBS improved immediately after taping in experimental group. -There were no significant differences between the first day and 24 hours in the control group. -Kinesiology tape application improves the results of forward reach test and COP medial/lateral displacement in stroke patients. -Kinesiology tape for correcting equinovarus seems to improve postural control in stroke patients.
Shin (5)	2017	n = 92 groups included -Taping, -Placebo, -Non-taping	Stroke (Chronic: > 6 months)	-Bio rescue	The ankle joint (ankle eversion taping)	-dynamic & static balance ability -LOS, sway length, sway speed	The ankle eversion group showed a significant difference in the limits of stability, sway length and sway speed compared to placebo and non-taping groups ($P < 0.05$). The ankle eversion taping immediately increases the ability of static and dynamic balance in chronic stroke patients with drop foot.
Iamburella (9)	2014	n = 11; exp: 6; cont: 5	Spinal cord injuries	-Handheld standard goniometer	Ankle joint	-BBS, -10MWT, -6MWT, -TUG, -balance ability & gait, -Level of PF EMG activity and passive ROM	-There were almost no changes between T0 and T48 in the placebo group but in the kinesiology tape treatment the passive ROM ($P < 0.005$) and the active ROM ($P < 0.001$) was significantly improved. -In the evaluation of the balance between T0 and T48, kinesiology tape significantly improved the balance ($P < 0.05$). -Gait parameters significantly improved in kinesiology T48 group. -Kinesiology tape has significant therapeutic effects on balance and gait improvement.
Yang (7)	2015	n = 38	Stroke (Chronic: > 6 months)	(Pazro) Shisel innovation system	Ankle and leg (extensor digitorum longus, cuneiform surface, plateau of tibia, peroneus longus, head of fibula)	kinematic analysis, -postural alignment, -foot pressure	- Comparison of the results of the foot pressure test before and after the taping showed a significant difference in the experimental group ($P < 0.05$). -The clinical use of kinesiology tape for chronic stroke patients who have asymmetrical and imbalanced body posture could be an optimal therapeutic approach. However, more documentation is required.
Yazici (10)	2015	N = 35, 18 stroke patients and 16 healthy subjects. Taping group: 10, Non-taping group: 9	Stroke (Subacute stage)	computerized dynamic posturography	Ankle and leg	balance	-Significant statistical differences were observed before taping in all sensory organization test parameters between stroke and control groups ($P < 0.05$). -To compare SOT between the patients with and without kinesiology tape, a significant difference was found ($P < 0.05$). -The application of kinesiology tape is promising in balance improvement in stroke patients.

Abbreviations: BBS, berg balance scale; COP, Center of pressure; Cont, control; COPA, center of pressure area; Exp, experimental; FRT, functional reach test; TUG, timed up and go test; LOS, limits of stability

improved lower-extremity spasticity, motor function, and balance after receiving kinesiology tape may explain the increased ambulation capacity (23-25). In conclusion, improvements in equilibrium score, and Sensory Organization Test was observed by examining the effect of kinesiology tape on balance in stroke subjects, which indicates that motor-sensory inputs can be enhanced by the application of kinesiology tape in cases where visual errors exist, visual feedback is prevented, or motor-sensory inputs are reduced. According to these findings, kinesiology tape helps motor-sensory inputs increase (17).

Non-elastic taping is a useful method for correcting joint alignment and enhancing muscle activity for the generation of force after musculoskeletal injuries (10, 11). The taping may place the muscle at a more mechanically right length to increase its contraction. Some studies have applied this technique to post-stroke. Kim et al., showed that this kind of tape could be used to decrease elbow flexor tone (26). Kilbreath et al. recommended that gluteal taping has an immediate effect on enhancing in the hip extension during stance phase in stroke subjects (27). Maguire et al. demonstrated that the hip abductor taping improves the affected hip abductor activity (28). These results support that taping improved muscle activation. The improvement in muscle activation of lower extremities may contribute to stable and independent walking (29). In addition, taping (Mulligan) has shown significance in gait cadence, gait velocity, and step length in stroke subjects (16). Mulligan taping is an effective intervention for functional improvement and joint alignment, and it also helps postural regulation. Ankle taping (Mulligan) significantly increases the dynamic stability and gait of stroke subjects (16). The other usage of taping is correction of talus equinus, which seems to be useful in postural control of stroke patients; therefore, the application of taping in the direction of mediolateral of ankle joint (in the direction of eversion-inversion motion) has significantly improved Forward Reach test, Berg balance scale indicators, and medial-lateral displacement of center of pressure (19). Reports indicated that the application of ankle eversion taping improves the center of pressure sway instantly, which includes sway length and sway speed in static balance and support level in dynamic balance (8).

4.1. Conclusions

Overall, this part of the study showed improvement of balance after using tape, and may facilitate ankle muscles activity by applying the correct foot posture; thus, increasing foot contact with the ground. Taping also increases cu-

taneous stimulation inputs, which can help improve foot posture and restore function and normal range of motion of the ankle joint by modifying the talus equinus deformity. Taping is also an immediate valuable technique for decreasing spasticity and related symptoms and improves balance and gait. The other point is that the taping keep skin constantly fit, which stimulates the mechanoreceptors, therefore, increasing the sending of sensory information to the brain (CNS). Therefore, taping can be an effective method for balance improvement in central nervous system diseases.

4.2. Study Limitations

Limitations of this systematic review include lack of a comprehensive listing of keywords that may have resulted in missed articles. Another limitation is the lack of specific focus on a specific disease or taping type. It is suggested that in future studies, the long-term effects of all type of tape on large groups of patients with various types of central nervous system diseases should be investigated.

Footnotes

Authors' Contribution: I would like to confirm that all authors were fully involved in the study and preparation of the manuscript. All of them have read and approved it.

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